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EXAMINER	
WONG, LINDA	
ART UNIT	PAPER NUMBER
2611	

SHORTENED STATUTORY PERIOD OF RESPONSE	NOTIFICATION DATE	DELIVERY MODE
3 MONTHS	04/27/2007	ELECTRONIC

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Office Action Summary	Application No.	Applicant(s)	
	10/682,160	KETCHUM ET AL.	
	Examiner	Art Unit	
	Linda Wong	2611	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
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- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 3/13/2007.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-4,7-12,14-16 and 18-34 is/are pending in the application.

4a) Of the above claim(s) 5,6,13 and 17 is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-4,7-12,14-16 and 18-34 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

Response to Arguments

1. Applicant's arguments filed 3/13/2007 have been fully considered but they are not persuasive.

The applicant contends

> "In the rejection, the Examiner asserts that Khatri discloses a method and apparatus as per claims 1-3, 5-6, 8-21, 25-26, 30, and 34. However, applicants submit that Khatri does not disclose "receiving orthogonal pilot transmissions from a plurality of antennas at the transmitter" as Claim 1 now recites. Khatri discloses transmitting an "omnidirectional or isotropic" pilot to receivers for purposes of channel estimation [0058]. Khatri does this for purposes of allowing all the receiver antennas to measure a single transmit antenna's "possible scatters" [0058].
>
> In conjunction, Khatri discloses the need to transmit the pilot "from a single antenna element 106 for a duration of one frame" (emphasis added) [0058]. In summary, the transmitted pilots are required to be transmitted one at a time in order for them to be distingishable from one another. Khatri does not disclose transmitted pilots orthogonally. Therefore, Khatri does not disclose "receiving orthogonal pilot transmissions from a plurality of antennas at the transmitter" as Claim 1 now recites.
>
> Zhuang does not disclose transmitting or receiving pilots anywhere. Therefore, Zhuang does not disclose "receiving orthogonal pilot transmissions from a plurality of antennas at the transmitter" as Claim 1 now recites. Therefore, neither Khatri nor Zhuang teach or disclose all of the limitations of the Claims. Claims 11, 15, 19, 26 and 30 contain similar limitations as to Claim 1, and for at least the same reasons as stated for Claim 1, Claims 11, 15, 19, 26 and 30 are patentable".

2. The examiner respectfully disagrees. Paragraph 0032 discloses "For example in OFDM systems, in effect, different sub-streams are sent at different carrier frequencies, the spacing of which are such that they are orthogonal and can be distinguished at the receiver." The disclosure indicates Khatri's system can function within an OFDM communication. As disclosed, the signals transmitted or received

are orthogonal due to the difference in carrier frequencies. Paragraph 0056 discloses "transmission of training sequences in the frame of bits, which are needed by the receiver in order to extra the sub-streams." The disclosure indicates the training signal, received with the signal transmitter, would be used to determine the sub-streams. As indicated in paragraph 0032, the sub-streams or signal received in an OFDM communication system are orthogonal due to the difference in carrier frequencies used to transmit the signal received by the receiver. Furthermore, paragraph 0056 discloses "there are two types of training sequences needed by the receiver; one to enable a measurement of the angular spectrum A(Ω) and one for determination of the transfer matrix H." The disclosure indicates the channel estimate, transfer matrix H, is determined using the training sequence. Given an OFDM communication system, the training sequences sent with the sub-streams are orthogonal and produces channel estimate based on the orthogonal training sequences.

3. Based on the rebuttal as stated above, amended claims 1,11,15,19,26,30 are rejected under Khatri in view of Zhang et al. The rejection below reflects the added limitations as well as the rebuttal above.

4. **Claims 2-4,7-10,12,14,16,18,20-25,27-29,31-34** is depend on claims 1,11,15,19,26,30. Due to the rebuttal of the independent claims as stated for claim 1, the rejection for claims 2-4,7-10,12,14,16,18,20-25,27-29,31-34 stands as stated. A copy is provided below.

Claim Objections

5. **Claim 1,7,11,15** are objected to because of the following informalities:
   a. **Claim 1, line 12, claim 11, line 12, claim 15, line 13** recites the limitation "the spatial filter", prior to mentioning a spatial filter on line 13 of claim 1, line 14 of claim 11, and line 16 of claim 15. Since the limitation is recited prior to the first mentioning of the limitation, the limitation lacks antecedent basis. It is suggested by the examiner to change line 12 to "a spatial filter response" and line 13 to "the spatial filter".
   b. **Claim 7,** Due to the cancellation of claims 5 and 6, claim 7 can no longer depend on claim 5.
   c. Appropriate correction is required.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

6. **Claims 1-3,5-6,8-21,25-26,30,34** are rejected under 35 U.S.C. 103(a) as being unpatentable over Khatri (US Publication No.: 20020127978) in view of Zhuang et al (US Patent No.: 20030123381).
   a. **Claims 1,11,15,**

- Regarding the limitation "obtaining a plurality of received symbol streams for a plurality of data symbol streams sent via a plurality of spatial channels of a MIMO channel in a wireless MIMO communication system", Khatri discloses "A receiver (RX) 112, also provided with a plurality of antennas 108, receives signals from the multiple paths which it then combines, decodes and demultiplexes to provide respective data streams to each application." (paragraph 0031) Khatri also discloses in the background of the specification improvements to a MIMO system comprises "multiple antennas enables spatial multiplexing, whereby a data stream for transmission is split into a plurality of sub-streams, each of which is sent via many different paths" (paragraph 0004) Khatri discloses "receiving signals from some or all the plurality of directions" (paragraph 0018)
- Regarding the limitation "spatial processing is performed at a transmitter with steering vectors, which are estimates of transmitter steering vectors required to orthogonalize the plurality of spatial channels", Khatri disclose calculating the steering vectors for the directions in which the sub-streams are to be transmitted. (paragraphs 0050-0053) "The receives signals across the array of antenna elements can be viewed as a vector ..." A multiple beam weighting matrix applies a set of weights to the vector, wherein the new vector are signals received from the directions that were previously determined. The weights are the same fro receiving and transmitting in a given direction. (paragraph 0062) Thus, the weights or the calculation of the steering vectors for the directions,

which are computed for the transmitter are also used by the receiver. Khatri discloses in the background of the invention an example of OFDM systems, wherein "the sub-streams are sent at different carrier frequencies which are such that they are orthogonal and can be distinguished by the receiver". (paragraph 0032) It would be obvious to one skilled in the art to determine orthogonal weights at the receiver so to be able to distinguish the different sub-streams.

- Regarding the limitation "receiving pilot transmissions from a plurality of antennas at the transmitter and wherein the estimated response matrix is obtained based on the received pilot transmission", Khatri discloses receiving a plurality of pilot transmissions from a plurality of antenna (Fig. 6, label 108) and calculating the channel impulse response based on a frame of bits. (paragraph 0042, Fig. 6, label 608)
- Regarding the limitation "obtaining an estimate of a channel response matrix for the MIMO channel; and deriving the spatial filter response based on the estimated channel response matrix", Khatri discloses determining the channel response matrix (Fig. 6, label 608) and deriving the spatial filter response based on the estimated channel response matrix (Fig. 6, label 606 and 304).
- Regarding the limitation "performing spatial processing on the plurality of received symbol streams with a spatial filter to obtain a plurality of filtered symbols streams, which are estimates of the plurality of data symbol streams", Khatri discloses receiving a plurality of streams, wherein weights are applied to

the plurality of streams to produce a plurality of filtered streams. (Fig. 6, labels 108, 304 and 308) By applying the weights to the streams, the system inherently produces filter streams, since filtered streams are received signals with adjusted coefficients or weights. Since the filtered streams are received signals with adjusted coefficients or weights, the filtered streams are estimates of the plurality of data streams.

- Regarding the limitation "the spatial filter has a response derived based on a minimum mean square error (MMSE) criterion that minimizes mean square error between the plurality of filtered symbol streams and the plurality of data symbol streams", Although Khatri fails to disclose using minimum mean square error criterion between the filtered symbols streams and data symbol streams, although Khatri fails to disclose using MMSE, Zhaung et al discloses a MMSE filtering. (paragraphs 0047-0050). It would be obvious to one skilled in the art to use MMSE to produce scaled weights so to reduce noise enhancement. (paragraph 0050)

b. **Claim 2,12,16**, Regarding the limitation "scaling the plurality of filtered symbol streams to obtain a plurality of recovered symbol streams, which are normalized estimates of the plurality of data symbol streams", Zhuang et al discloses "one may scale each row of WH,k so that the diagonal elements of WH,kHk equal 1." "The above normalization amounts to re storing the symbol as close to the constellation as possible ..." (paragraph 0050)

c. **Claim 3**, the mathematical formula/expression of the filter; the mathematical formula is inherently provided and is not unique.

d. **Claim 8**, Regarding the limitation "receiving a steered pilot via the plurality of spatial channels; and deriving the spatial filter response based on the received steered pilot", Khatri discloses plurality of spatial channels (paragraph 0004) and determining the channel estimate which affects the spatial filter (Fig. 6, labels 608 and 606). Kharti also discloses "training sequence contains all possible scatterers in the environment (i.e. a signal sent omnidirectionally or isotropically from the transmitter 106). This could, for example, be achieved by transmitting from a single antenna element 106 for a duration of one frame (assuming that he lement is omindirectional). As will be discussed below the training signal should also allow measurement of the transfer matrix H." (paragraph 0058)

e. **Claims 9,21,** Regarding the limitation "the plurality of data symbol streams are spatially processed at the transmitter with a plurality of steering vectors obtained by decomposing an estimate of a channel response matrix for the MIMO channel", Zhuang et al. discloses decomposing an estimate of a channel response matrix to spatially process the plurality of data symbol streams (FIG.I, [0037] wherein the Hk channel matrix is decomposed at subcarrier)

f. **Claims 10,14,18,25 & 34**, Regarding the limitation "MIMO system implements orthogonal frequency division multiplexing (OFDM) and wherein the spatial processing is performed for each of a plurality of subbands", Zhuang et al.

discloses the MIMO system implementing orthogonal frequency division multiplexing (OFDM) (23 & 24 FIG.2, [0002]), wherein for each of a plurality of subbands is performed.

g. **Claims 19,26,30** recites similar limitations as recited in claim 1, thus the rejection regarding the limitations "obtaining a plurality of data symbol streams ...", "the plurality of steering vectors are estimates of transmitter steering vectors..." and "wherein the plurality of data symbol streams are recovered at the receiver ..." are rejected as stated in the rejection of claim 1. Claim 1 fails to recite the limitations

A. "an estimator operative to obtain an estimate of a plurality of steering vectors, wherein the plurality of steering vectors is based on received orthogonal pilot transmission" and

B. "performing spatial processing on the plurality of data symbols streams with a plurality of steering vectors, one steering vector for each data symbol steam, to obtain a plurality of transmit symbol streams for transmission from a plurality of transmit antennas".

- Regarding limitation A, Khatri discloses such a limitation. (Rebuttal as stated above, paragraphs 0032,0056, and Fig. 6, label 608 as the estimator)
- Regarding limitation B, Khatri discloses performing spatial processing on the plurality of data symbols streams (Fig. 6, labels 304,606) using a plurality of steering vectors (paragraphs 0050-0052) and determining the transmit signals based on the received signals (paragraph 0010).

h. **Claim 20**, the limitations as recited is the mathematical formula/expression of orthogonal spatial channels; the mathematical formula is provided by the spatial processing and is not unique.

7. **Claims 22-24,27-29,31-33** are rejected under 35 U.S.C. 103(a) as being unpatentable over Khatri (US Publication No.: 20020127978) in view of Zhuang et al (US Patent No.: 20030123381) and further in view of Crilly, Jr. et al (US Patent No.: 6611231).

a. **Claims 22,27,31**,

A. Khatri fails to disclose "the wireless MIMO communication system is a time division duplex (TDD) system, wherein the plurality of data symbol streams are transmitted on a first link of the MIMO channel, and wherein the plurality of steering vectors are derived based on an estimate of a second link of the MIMO channel".

B. Crilly, Jr. et al discloses a MIMO TDD and spatial diversity implemented in a communication system (Col. 10, lines 35-43). Crilly, Jr. et al further discloses transmitting measured information, such as identifiers, location information or steering information for spatial processing from the first wireless routing device to the second wireless routing device (Col. 22, lines 21-62) The second wireless routing device will use the steering information to selectively place peaks and null in the directions for each beam so to provide connectivity. (Fig. 15 and Col. 22, lines 11-62) By providing connectivity between the second and first wireless device, the communication system inherently allows for transmission of information between the two devices. Thus, the first wireless device can transmit information, such as data information, to the second wireless device. Since transmission of the steering information is necessary in order for the second wireless device to selectively place peaks and nulls in the direction for connectivity (Fig. 15, Col. 22, lines 11-62), consecutively, data information will be transmitted on the next or on the second link. It would be obvious to one skilled in the art to incorporate the limitations as recited by Crilly, Jr. et al into Khatri's invention to provide proper communication.

b. **Claims 23-24,28-29,32-33** recites similar limitations as recited in claims 8,9, thus the rejection of claims 23-24,28-29,32-33 are rejected as stated for claims 8 and 9.

Allowable Subject Matter

8. **Claims 4 and 7** are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

9. The following is a statement of reasons for the indication of allowable subject matter:

a. The prior art of record fails to teach or suggest, alone or in a combination, among other things, at least a method of performing spatial processing at a receiver in a wireless multiple-input multiple-output (MIMO) communication system as a whole, the combination of elements and features, which includes the minimum mean square error (MMSE) criterion given as min E[(Wr-s)H (Wr-s)] or the spatial filter response is derived in accordance with the formula recited in the claims.

Conclusion

10. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.
    a. Hudson (US Publication No.: 200300438087)
    b. Lei et al (US Publication No.: 6850741)
    c. Thielecke et al (US Publication No.: 20040052315)
    d. Honing (US Patent No.: 6956897)
    e. Chi et al (US Publication No.: 20030091134)

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Linda Wong whose telephone number is 571-272-6044. The examiner can normally be reached on 9-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, David Payne can be reached on (571) 272-3024. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Linda Wong
4/16/2007

JAY K. PATEL
SUPERVISORY PATENT EXAMINER